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**University of Zimbabwe**

The mandibular angles of dry adult human mandibles from north eastern arid zone of Nigeria

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Abstract

Objectives: To study and document the mandibular angle of Nigerians from the north eastern arid zone, and investigate its role as an anthropological parameter for racial and or population groups differential diagnosis, its utilization in laryngoscopy and for successful inferior alveolar nerve anesthesia.

Design: A cross sectional study.

Setting: Department of Anatomy, College of Medical Sciences, University of Maiduguri, Maiduguri, Borno State, Nigeria.

Subjects: 60 dry adult mandibles from Nigerians who lived in Maiduguri (Borno State Capital) and its environ until their death.

Main Outcome Measures: Measurements of the right and left mandibular angles, length and height of the mandibles and the comparison of the mean angle with that of other racial and or population groups.

Results: The mean mandibular angle (118.75 ± 0.395 i.e. mean \pm SEM) was smaller than that of other African populations but was wider than that of the Neanderthals and similar to that of the Chinese and Peruvians. The mandible had a shorter ramus, slightly longer length resulting in a smaller angle than that of the Zimbabwean mandible. Highly significant differences occurred between the mean angle of the Nigerian mandible and those of other African population groups ($p < 0.0001$) except the mandibular angle of Natal Nguni and Cape Nguni populations from South Africa. There was no mutual dependence and no significant departure from linearity between the mean angle, length and height.

Conclusion: The mandibular angle in conjunction with other anthropological parameters may be useful anthropological tools in racial and or population diagnosis. The configuration of the mandible of Nigerians from the northeast arid zone may predispose them to difficult laryngoscopy and/or intubation.

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Introduction

The morphology of bones is regulated by a combination of intrinsic and extrinsic factors.^{1,2} Genetic factors and environmental factors act as primary factors within which functional activity operates as a secondary factor.^{1,2} Racial and regional differences in functional activity of the mandible during the early stages of development may affect its form and hence the position of the mandibular foramen³ and the mandibular angle.⁴ The angle of mandible (Figure I) varies with age and the state of the dentition. It ranges from about 170° in children to about 110° to 120° in adolescence and adulthood and then increases to about

130° to 140° in old age.⁵ These changes have been associated with the action of the masseter, medial pterygoid and temporal muscles.⁶ Several authors have shown that the state of dentition (such as tooth eruption, loss of teeth and absorption of the alveolar bone) is an important factor determining the size of the human mandibular angle.^{5,7} On the other hand, the size of the mandibular angle has been suggested as an important anatomic factor that may cause difficulty in laryngoscopy,^{8,9} and as a useful anthropological parameter in accurate and successful inferior alveolar nerve anesthesia,¹⁰ since the angulation is linked to the position of mandibular foramen through the mandibular growth potential.^{10,11} Gabriel⁴ also found that the more

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oblique the angle of the mandible, the further forward and higher up the mandibular foramen would be. Some studies have also shown that the mandibular angle varies in different human population groups.¹²

The available literature shows that the mandibular angle of some human population groups has been studied but that of the Nigerian mandible is, however, yet to receive any attention from researchers. Nigeria has a population of over one hundred million people, and is a multi ethnic society with different racial histories among the major population groups. Nigeria has varied climatic conditions and cultural practices, including food habits in the different regions and between different areas of the same region. With such great diversity, it is desirable to record the normal average mandibular angles for every population grouping. The findings will provide reference anthropological data that can also be useful in dental and medical practice in a given area.

Description of Study Area and Population.

The area covered by the present study, has a land area of about 1 165 900ha and has been described in a previous report.¹³ Briefly, Borno State is situated in the extreme north eastern arid zone of Nigeria, in the Sudano-Sahelian vegetation belt. The state lies approximately within longitude 10° and 15° E and latitude 10° and 14° N of the equator, while Maiduguri, the State capital, lies at approximately 13° and 11° N of the equator. Ecoclimatically, Borno State therefore lies in the Sahel, Sudan and northern Guinea savanna. The Maiduguri metropolis is predominantly populated by the Kanuris with the Shuwa Arabs and Babur/Bura peoples sparsely scattered among them.

Materials and Methods

The mandibles were obtained from the skeletal collection of the Department of Anatomy, College of Medical Sciences, University of Maiduguri, Maiduguri, Borno State, Nigeria. Sixty dry unsexed normal adult human mandibles of northeast Nigerian origin with all the teeth *in situ*, were used. The mandibles were all from adults as judged by dental (the third molars had completely erupted) and chronologic ages. The chronologic ages of the cadavers were obtained from departmental records, but their sex was not recorded. The ages range from 25 years and above.

The angle was measured according to the standard technique for mandibular angle measurements introduced by Morant¹⁴ and followed by^{5,12} Zivanovic and Mbajorgu *et al.* (Figure I). This technique involved measuring the mandibular angle with the osteometric table or mandibulometer. The osteometric table or mandibulometer has horizontal and vertical planes. The standard horizontal plane is the plane of the osteometric table (or mandibulometer) and the vertical plane represents the ramal wing of the mandibulometer. The lower border of the body of the mandible was placed on the horizontal plane of the mandibulometer. The posterior borders of

both rami of the mandible were then pressed against the ramal wing (vertical plane) of the mandibulometer. The angle as measured was recorded on each side. The length and height of each mandible were measured (on the right and left sides) with the standard horizontal and standard ramal planes of the osteometric table (Figure I). Also the distance from the lower border of the mandibular foramen to the mandibular angle (i.e. junction between the body and ramus) of each mandible (CD) and the narrowest anteroposterior ramal width (AB) were measured on both sides using a vernier calliper (Figure II).

Figure I : A diagram to illustrate angle (X), the length and height of the left mandible.

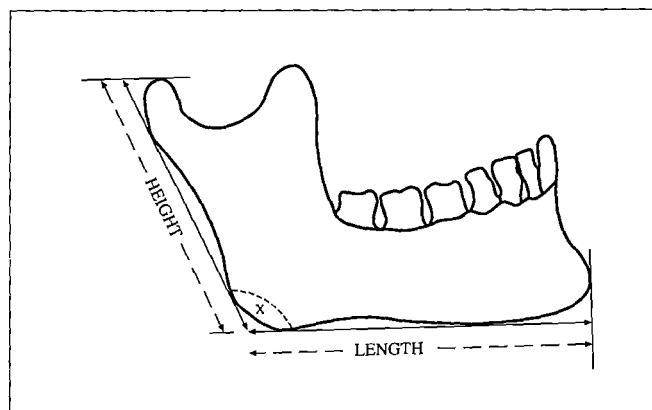
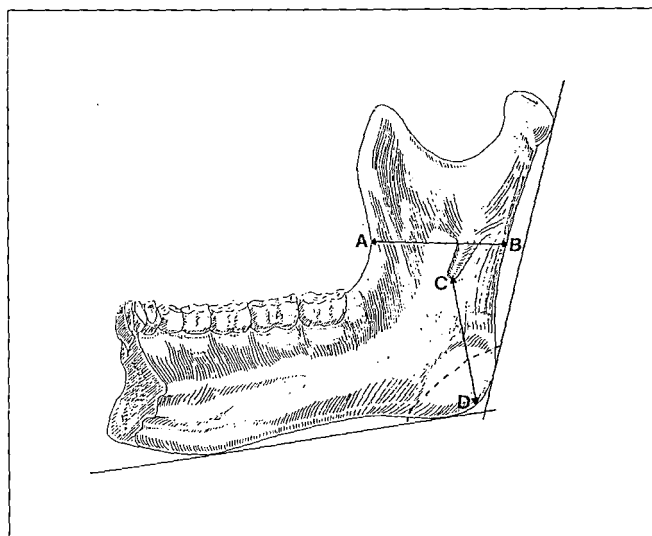


Figure II: A diagram to illustrate narrowest anteroposterior ramal width (AB) and the distance (CD) from the lower border of mandibular foramen to the angle of the right mandible.



Statistical Analysis.

The data obtained were analyzed using the statistical software (Graphpad) INSTAT tm 2.04a. The significance of the differences between the left and the right sides of the mean parameters were tested using the Students' t-test. The correlations between the mean angle and length, mean angle and height and mean length and height were also

tested. The 5% statistical significant level was adopted for all the statistical tests.

Results

The results were as shown in Table I. There was no mutual dependence between the mean angle and length ($r = -0.204$; $p = 0.599$), mean angle and height ($r = -0.50$; $p = 0.171$), and mean length and height ($r = 0.493$; $p = 0.178$). The range of variation for the length and the height were small but that of the angle was relatively wide. The coefficient of variation for the height was slightly greater than that of the length but this difference was not significant ($p = 0.257$, Table I). The mandibles showed slight asymmetry but the differences between the right and left sides in the measurements were not statistically significant ($p = 0.769$). Subsequently right and left side data were pooled. The difference between the mean right and left angles was only 0.1° . The linear regression model showed that the slope between the mean angle and length, mean angle and height, mean length and height was not significantly different from zero ($p = 0.5988$; 0.1710 and 0.1776 respectively). There was also no significant departure from linearity between the angle and length, angle and height of the mandible as well as between the length and height ($p = 1.0000$; 0.9921 and 0.2619 respectively).

Table I: Comparison of the mean angle, length and height of mandible of Nigerian and Zimbabwean subjects.

A: North-East (Arid zone)	n	Mean \pm SE	Range	**CV(pc)
Nigerian Mandible				
Angle	60	118.750 ± 0.395	110.5 - 130	3.085
Length	60	8.056 ± 0.375	5.3 - 9.2	13.965
Height	60	5.592 ± 0.306	4.2 - 7.3	16.423
B: Black Zimbabwean Mandible*				
Angle	32	125.530 ± 0.553	117 - 130	1.705
Length	32	7.505 ± 0.230	6.6 - 8.7	7.295
Height	32	6.055 ± 0.272	5.1 - 7.2	11.065

*Mbajorgu, et al., 1996.

**CV (pc) – coefficient of variation in percent.

The mean distance (CD; Figure II) from the inferior margin of the mandibular foramen to the angle of the mandible was 21 ± 0.37 mm with a range 13.67 to 32.2mm while the mean of the narrowest anteroposterior ramal width (AB) was 34 ± 0.45 mm with a range 20.67 to 43.6mm. These distances AB and CD showed a high significant correlation with angle (AB: $r = 0.9850$, $p = 0.0003$; CD: $r = 0.9906$, $p = 0.0001$) and there was no significant departure from linearity (AB: $p = 0.400$ and CD: $p = 0.700$).

Table II shows the range and mean of mandibular angles of some population groups from Eastern, Southern and Western African populations. Interestingly the minimum and the maximum angle values (101 to 142) were those of the East African population group, but the widest (128.05) and narrowest (118.75) mean mandibular angle values

were those of South Africa and West Africa population groups respectively.

Table II: The mandibular angle in the Eastern, Southern, and West African populations:

Population	n	Mean \pm SE	Range	Authors
East African (EA)	310	124.05 ± 0.76	101-142	Zivanovic (1970)
South Africa (SA)	496	126.80 ± 0.43	103-138	De Villiers (1968)
Natal Nguni (SA)	137	123.60 ± 0.835	105-138	" "
Cape Nguni (SA)	107	120.35 ± 0.97	103-135	" "
Sotho (SA)	156	123.60 ± 0.66	107-138	" "
Shangani-Tonga (SA, males)	35	120.30 ± 0.77	104-131	" "
Black Zimbabwean (SA)	32	125.53 ± 0.684	117-130	Mbajorgu et al (1996)
North-East Arid zone of Nigeria (WA)	60	118.75 ± 0.395	110.5-130	(present study)

EA = Eastern Africa.

SA = Southern Africa.

WA = Western Africa.

Table III shows the mean mandibular angles from different racial population groups. The widest mandibular angle was that of the Europeans (128°) and the narrowest that of the Neanderthals (110°).

Table IV compares the mandibular angles of some African mandibles. Significant differences occurred between the various mandibular angles in most groups except between mandibular angles of the Nigerian and Cape Nguni mandibles, Natal Nguni and Sotho, and Cape Nguni and Shangani Tonga, which were not significantly different.

Table III: Mean mandibular angle in different populations.

Population	Angle	Author
Negroes	125°	Martin (1928) ²⁴
Europeans	128°	" "
Neanderthals	110°	" "
Chinese and Peruvians	119°	" "
Aboriginal Australians	124°	" "
Xanthoderms and African Negroes	120°	" "
White males (Dutch descent)	125.6 ± 4	Weijss and Hillen, (1986) ²⁵
Zimbabweans (Black)	125.53 ± 0.55	Mbajorgu et al., (1996) ¹²
North-Eastern Arid zone of Nigerian (Black)	118.75°	(present study)

Discussion

There is likely to be a significant amount of error in attempting sex determination when the sex of the bones was not prerecorded. For this reason the mandibles were not differentiated by sex.¹⁵ However available literature suggests a $3^\circ/5^\circ$ difference between the angles of the male and female mandibles.^{5,11,16}

The angle of mandible from the northeast arid zone of Nigeria was the narrowest amongst the mandibular angles reported in African populations (Table I and II). The

Table IV: Comparison of the mean mandibular angle of the various black mandibles.

	NMA	ZWMA	EAMA	SAMA	NNMA	CNMA	SOMA	STMA
NMA	.	<0.0001	0.0069	<0.0001	0.0001	0.1154	<0.0001	0.0252
ZWMA		.	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EAMA			.	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
SAMA				.	<0.0001	<0.0001	<0.0001	<0.0001
NNMA					.	<0.0001	<0.0001	<0.0001
CNMA						.	<0.0001	0.3909
SOMA							.	<0.0001
STMA								.

*p values of this comparison are shown in the table.

NMA = Nigerian mandibular angle.

ZWMA = Zimbabwean mandibular angle.

EAMA = East African mandibular angle.

SAMA = South African mandibular angle.

NNMA = Natal Nguni mandibular angle.

CNMA = Cape Nguni mandibular angle.

SOMA = Sotho mandibular angle.

STMA = Shangana Tonga mandibular angle.

Nigerian mandible also showed a slightly greater mandibular length but shorter ramal height than that of the black Zimbabwean mandible. This configuration of the Nigerian mandible may be responsible for the narrower mandibular angle. The ramus was found to be positioned antero-superiorly relative to the body of the mandible as against a more postero-superior position found in the Zimbabwean mandible, hence the difference in the size of the angles. The study have also shown that the mean angle of the mandible from the north eastern arid zone of Nigeria was highly significantly different from those of other African populations except that of Cape Nguni which did not differ significantly from it (Table IV). Though Zivanovic¹ reported no significant difference between the mandibular angles of the East African and South African Bantu populations, our results showed significant differences between the mandibular angle of Nigerians from the northeast arid zone and those of the East and South African Bantu populations (Table IV). With exception of the mandibular angle of Natal Nguni versus Sotho and Cape Nguni versus Shangana Tonga, it was observed that the angles of the rest of the African mandibles were significantly different from each other (Table IV). It seems, therefore, that the mandibular angle as an anthropological parameter may be useful for racial and or population diagnosis. The non-significant difference between the mandibular angles of Nigerian / Cape Nguni, Natal Nguni / Sotho and Cape Nguni / Shangana-Tonga, demonstrates some degree of homogeneity between these population groups (Table IV). However, the mandibular angle in conjunction with other anthropological parameters/measurements may be useful in differential diagnosis of populations and or racial groups.

Table III shows that the mandibular angle of the northeast arid zone of Nigerian mandible was greater than that of the Neanderthals, similar to the mean angles of the Chinese and Peruvians and smaller than those of other populations (Table III). Moreover, the difference between this mandibular angle and that of the European mandible is

relatively wide and may be considered for racial diagnosis. However the test of significance could not be carried out because of incomplete data available on the European mandible (Table III).

The morphology (size and shape) of the mandibles may explain the above variations. According to Moss,¹⁷ the morphology or form of the mandible is meaningful only in terms of its functions. All functions occur within a matrix of related soft tissues and two basic types of functional matrices are described: periosteal and capsular.¹⁷ For the purpose of this paper, only periosteal matrices need to be discussed. The mandibular matrix consists in part of all muscles with mandibular attachment; neuromuscular triads (arteries, veins and nerves); associated salivary glands; the teeth; fat, skin and connective tissue; the oral and pharyngeal cavities. Thus, since Moss¹⁷ considers that the mandible is situated, grows and functions within this matrix, this should be reflected in the structure of the mandible.

The ramus of the mandible is associated with the attachment of the temporalis, medial and lateral pterygoid muscles (these muscles being example of periosteal matrix), so that this region of the mandible should reflect variation in muscle function. Experimental data make it clear that extirpation/removal or denervation of the temporalis muscle produces marked reduction of the coronoid or angular processes of the mandible respectively.^{6,18} Conversely, masseteric hypertrophy leads to an enlargement of the angular process.^{9,20} Briefly, it is experimentally and clinically demonstrable that periosteal functional matrices are morphogenetically and temporally *primary*; and that the presence, form (size and shape), and transformative growth²¹ of any skeletal unit is *secondary*, compensatory, and mechanically obligatory to temporally prior changes in the related periosteal functional matrices.²² The morphology of bones is therefore regulated by a combination of intrinsic and extrinsic factors; genetic and environmental factors act as primary factors within which functional activity operates secondarily.^{1,2}

As reported by Zivanovic,²³ the results confirmed that the asymmetry in the mandible does not affect the mandibular angle. It also agrees with Keen⁷ who reported that the difference between the right and left angles was statistically insignificant and falls within the range of the standard error of the mean.

In accordance with the findings of Gabriel,⁴ the results seem to suggest that the mandibular foramen for the mandible from the north eastern arid zone of Nigeria may be positioned higher up the ramus. However, the mathematical and statistical evaluation of locating the exact position of the mandibular foramen using the size of the angle is beyond the scope of the present study, further studies are focusing on this area. Furthermore, the north eastern arid zone of Nigerian mandible, with its significantly short ramus and small angle may present a substantially longer mandibulohyoid distance than normal suggesting important, unfavourable anatomic factors that may predispose this Nigerian population to difficult

laryngoscopy and or intubation. This is in line with the findings of Chou and Wu⁸ and Charters.⁹ Finally, the results will be useful in assessing changes in the size of the angle during such processes as teeth eruption, loss of teeth, disease conditions such as rickets and in dental manoeuvres involving the inferior alveolar nerve in this population group.

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